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Technical specification of grid-connected PV inverter

并网光伏发电专用逆变器技术条件

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Technical specification of grid-connected PV inverter

1 Scope

This technical specification specifies the product classification, terms and definitions, technical requirements, test methods, inspection rules and marking, packaging, transportation and storage of grid-connected PV inverters.

This technical specification is applicable to photovoltaic power generation inverter for grid connection.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB 4208-2008	*Degrees of protection provided by enclosure (IP code)* (IEC 60529: 2001, IDT)
GB 7260.2-2009	*Uninterruptible power systems (UPS) - Part 2: Electromagnetic compatibility (EMC) requirements* (IEC 62040-2: 2005, IDT)
GB 10593.1-2005	*Measuring methods of environmental parameters for electric and electronic products - Part 1: Vibration*
GB/T 191-2008	*Packaging - Pictorial marking for handling of goods*
GB/T 2423.1-2008	*Environmental testing for electric and electronic products - Part 2: Test methods - Tests A: Cold* (IEC 60068-2-1: 2007, IDT)
GB/T 2423.2-2008	*Environmental testing for electric and electronic products - Part 2: Test methods - Test B: Dry heat* (IEC 60068-2-2: 2007, IDT)
GB/T 2423.3-2006	*Environmental testing for electric and electronic products - Part 2: Testing method - Test Cab: Damp heat steady state* (IEC 60068-2-78: 2001, IDT)
GB/T 3859.2-1993	*Semiconductor convertors - Application guide* (IEC 60146-1-2: 1991, EQV)
GB/T 12325-2008	*Power quality - Deviation of supply voltage*
GB/T 12326-2008	*Power quality - Voltage fluctuation and flicker*
GB/T 13384-2008	*General specifications for packing of mechanical and electrical product*
GB/T 14549-1993	*Quality of electric energy supply - Harmonics in public supply network*
GB/T 15543-2008	*Power quality - Three-phase voltage unbalance*
GB/T 15945-2008	*Power quality - Frequency deviation for power system*

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GB/T 17626.2-2006	*Electromagnetic compatibility (EMC) - Testing and measurement techniques - Electrostatic discharge immunity test* (IEC 61000-4-2: 2001, IDT)
GB/T 17626.3-2006	*Electromagnetic compatibility - Testing and measurement techniques - Radiated radio-frequency electromagnetic field immunity test* (IEC 61000-4-3: 2002, IDT)
GB/T 17626.4-2008	*Electromagnetic compatibility - Testing and measurement techniques - Electrical fast transient/burst immunity test* (IEC 61000-4-4: 2004, IDT)
GB/T 17626.5-2008	*Electromagnetic compatibility - Testing and measurement techniques - Surge immunity test* (IEC 61000-4-5: 2005, IDT)
GB/T 17626.6-2008	*Electromagnetic compatibility - Testing and measurement techniques - Immunity to conducted disturbances induced by radio-frequency fields* (IEC 61000-4-6: 2006, IDT)
GB/T 17626.8-2006	*Electromagnetic compatibility - Testing and measurement techniques - Power frequency magnetic field immunity test* (IEC 61000-4-8-2001, IDT)
GB/T 17626.12-1998	*Electromagnetic compatibility - Testing and measurement techniques - Oscillatory waves immunity test* (IEC 61000-4-12: 1995, IDT)
GB/T 17626.14-2005	*Electromagnetic compatibility - Testing and measurement techniques - Voltage fluctuation immunity test* (IEC 61000-4-14: 2002, IDT)
GB/T 18479-2001	*Terrestrial photovoltaic (PV) power generating systems - General and guide* (IEC 61277: 1995, IDT)
GB/T 20514-2006	*Photovoltaic systems - Power conditioners - Procedure for measuring efficiency* (IEC 61683: 1999, IDT)
GB/Z 6829-2008	*General requirements for residual current operated protective devices*
IEC 62109-1-2010	*Safety of power converters for use in photovoltaic power systems - Part 1: General requirements*
IEC 62109-2-2011	*Safety of power converters for use in photovoltaic power systems - Part 2: Particular requirements for inverters*
EN 50530-2010	*Overall efficiency of grid connected photovoltaic inverters*
IEC 60990-1999	*Methods of measurement of touch current and protective conductor current*
IEC 62116-2008	*Test procedure of islanding prevention measures for utility - Interconnected photovoltaic inverters*
Q/GDW 617-2011	*Technical rule for photovoltaic power station connected to power grid*
Q/GDW 618-2011	*Technical procedures for photovoltaic power station connected to power grid*

3 Terms and definitions

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For the purposes of this technical specification, the following terms and definitions apply.

3.1 photovoltaic grid-connected inverter

equipment that converts DC power generated by solar cells into AC power and feeds it into power grid

Note 1: Inverters mentioned in this specification refer to photovoltaic grid-connected inverters;

Note 2: The technical requirements and test methods specified in this specification are not applicable to inverters in AC MODULE.

3.2 photovoltaic array simulator

power source for simulating static and dynamic current and voltage characteristics of photovoltaic array

3.3 inverter AC output terminal

power outputting connection point on AC side of the inverter

3.4 maximum powder point tracking

automatic adjustment behavior of tracking and controlling the changes of output voltage and current caused by the changes of surface temperature and solar irradiance of photovoltaic modules to keep the array working at the maximum output all the time, and further to obtain the maximum power output

3.5 maximum powder point tracking efficiency

ratio of the DC power obtained by the inverter under test to the power theoretically provided by the PV simulator working at the maximum power point within the specified measurement period T_M

$$\eta_{MPPT} = \frac{\int_0^{T_M} P_{DC}(t) \cdot dt}{\int_0^{T_M} P_{MPP}(t) \cdot dt} \quad (1)$$

Where,

$P_{DC}(t)$——the instantaneous input power obtained by the inverter under test.

$P_{MPP}(t)$——the instantaneous MPP power theoretically provided by PV simulator.

3.6 conversion efficiency

ratio of the energy output by the AC port to that input by the DC port of inverter within the

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specified measurement period T_M

$$\eta_{conv} = \frac{\int_0^{T_M} P_{AC}(t) \cdot dt}{\int_0^{T_M} P_{DC}(t) \cdot dt} \tag{2}$$

Where,

$P_{AC}(t)$——the instantaneous output power of inverter AC port;

$P_{DC}(t)$——the instantaneous input power of inverter DC port.

3.7 overall (total) efficiency

ratio of the energy output by the inverter AC port to the power theoretically provided by the PV simulator within the specified measurement period T_M

$$\eta_t = \frac{\int_0^{T_M} P_{AC}(t) \cdot dt}{\int_0^{T_M} P_{MPP}(t) \cdot dt} = \eta_{conv} \cdot \eta_{MPPT} \tag{3}$$

3.8 islanding

state of the photovoltaic system of keeping supplying power to some circuits in the power grid when the power grid loses voltage

3.9 intentional islanding

intentional islanding according to the pre-configured control strategy

3.10 unintentional islanding

unintentional and uncontrollable islanding

3.11 anti-islanding

prohibition of unintentional islanding

Note: In the case of unintentional islanding, because the power supply state of the system is unknown, it will cause the following adverse effects: ① it may endanger the life safety of maintenance personnel and users of power grid lines; ② it will interfere with the normal closing of the power grid; ③ the power grid can't control the voltage and frequency in island, thus damaging distribution equipment and user equipment.

3.12 simulated utility

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test device used to simulate the public power grid, with adjustable voltage and frequency

3.13 quality factor

evaluation index of resonance ability of test load in anti-islanding protection test

Note: In parallel RLC resonant circuit, the load quality factor Q_f may be expressed by the following equation:

$$Q_f = R\sqrt{C/L} \tag{4}$$

Where,

Q_f——the load quality factor;

R——the load resistance;

C——the load capacitance;

L——the load inductance.

Given the known active power, inductive reactive power and capacitive reactive power consumed by the parallel RLC resonant circuit, Q_f may also be expressed as:

$$Q_f = \sqrt{Q_L \times Q_C}/P \tag{5}$$

Where,

Q_L——the reactive power consumed by inductance L;

Q_C——the reactive power consumed by capacitor C;

P——the active power consumed by resonant circuit.

3.14 resonant frequency

resonant frequency of parallel RLC circuit, which is defined as follows:

$$f = \frac{1}{2\pi\sqrt{LC}} \tag{6}$$

Where,

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f——the resonant frequency;

L——the load inductance;

C——the load capacitance.

Note: When the parallel RLC circuit resonates, the inductive reactive power consumed by the circuit is equal to the capacitive reactive power, so the parallel RLC resonant circuit is equivalent to pure resistance.

3.15 temporary

modifier used to quantify the duration of short-time change within a range of 3s~1min

4 Product classification

4.1 Product types

4.1.1 Classification according to the number of output AC phases

a) Single-phase inverters;

b) Three-phase inverters;

c) Multiphase inverters.

4.1.2 Classification according to the installation environment

a) Indoor type;

b) Outdoor type;

4.1.3 Classification according to the achievable power flow direction

a) Reversible type;

b) Irreversible type.

4.1.4 Classification according to the electrical isolation conditions

a) Isolated type;

b) Non-isolated type.

4.1.5 Classification according to the voltage level of accessible power grid

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